Algorithm predicts dangerous low blood pressure during surgery

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Scientists have developed an algorithm that predicts potentially dangerous low blood pressure, or hypotension, that can occur during surgery. The algorithm identifies hypotension 15 minutes before it occurs in 84 percent of cases, the researchers report in a new study published in the Online First edition of *Anesthesiology*, the peer-reviewed medical journal of the American Society of Anesthesiologists (ASA).

A variety of factors can impact blood pressure during surgery. In some people, these factors may cause a significant drop in blood pressure.

"Physicians haven't had a way to predict hypotension during surgery, so they have to be reactive, and treat it immediately without any prior warning. Being able to predict hypotension would allow physicians to be proactive instead of reactive," said lead researcher Maxime Cannesson, M.D., Ph.D., professor of anesthesiology and vice chair for perioperative medicine at UCLA Medical Center in Los Angeles. "By finding a way to predict hypotension, we can avoid its complications, which can include postoperative heart attack and acute kidney injury, that can lead to death in some cases."

Serious complications can develop quickly, and the risk of serious complications increases the longer a patient remains hypotensive. Advance warning that hypotension is imminent, even if the warning comes only 10 to 15 minutes ahead, could reduce the risk of harm to patients, the authors note.

In the study, researchers used a technique called machine learning, a discipline within computer sciences that focuses on the application of algorithms to provide computers with the ability to learn and detect patterns associated with a specific outcome in large datasets. The algorithm was developed to observe subtle signs in routinely collected physiological data that could predict the onset of hypotension in surgical patients.

The researchers used two sets of data to build and validate the predictive algorithm. One data set, used for training, consisted of 1,334 patient records with 545,959 minutes of arterial pressure waveform recordings—recordings of the increase and decrease of blood pressure in the arteries during a heartbeat. That data set included 25,461 episodes of hypotension. A second data set, used for external validation of the model, consisted of 204 patient records with 33,236 minutes of arterial pressure waveform recordings and 1,923 episodes of hypotension.

For each heartbeat, the scientists were able to extract 3,022 individual features from the arterial pressure waveforms. When combined, these features yielded more than 2.6 million bits of information used to build the algorithm. The authors found the algorithm was able to accurately predict an intraoperative hypotensive event 15 minutes before it occurred in 84 percent of cases, 10 minutes before in 84 percent of cases, and 5 minutes before in 87 percent of cases.

"We are using machine learning to identify which of these individual features, when they happen together and at the same time, predict hypotension," Dr. Cannesson said. "The statistical association between these features and the occurrence of hypotension is fascinating because we can potentially reverse engineer this statistical association and augment our understanding of this complex physiological phenomenon."

Software that uses the new algorithm, made by Edwards Lifesciences, was granted a De Novo request in March 2018 by the U.S. Food and Drug Administration. It has been commercially available in Europe since 2016, Dr. Cannesson noted.

"It is the first time machine learning and computer science techniques have been applied to complex physiological signals obtained during surgery," Dr. Cannesson said. "Although future studies are

needed to evaluate the real-time value of such algorithms in a broader set of clinical conditions and patients, our research opens the door to the application of these techniques to many other physiological signals, such as EKG for cardiac arrhythmia prediction or EEG for brain function. It could lead to a whole new field of investigation in clinical and physiological sciences and reshape our understanding of human physiology."

Provided by American Society of Anesthesiologists